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Working Paper

Measuring the Knowledge Base of Regional Innovation Systems in Germany in terms of a Triple Helix Dynamics

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Contents

Abstract

While a market economy seeks equilibrium, a knowledge-based economy may upset this tendency towards stabilization by adding the feedback of globalization. The interaction among the three subdynamics of economic exchange, technological innovation, and institutional control can be captured with a generalized Triple Helix model. We propose to use the mutual information as an indicator of integration among the three subdynamics at the systems level. This probabilistic entropy can be positive or negative. On the basis of data at the district level in Germany the conclusions of a previous study about the Netherlands are tested: medium-tech manufacturing is the main driver of a knowledge-based configuration in a regional economy, while knowledge-intensive services tend to uncouple the economy from the regional configuration. At the level of regions (NUTS-2) the knowledge-based economy is no longer structured by the previous East-West divide of the country, while this divide has remained the main structure at the level of the states (NUTS-1) which constitute the Federal Republic.

JEL classification: C14, O18, O31, R12

Keywords: Knowledge economy, Triple Helix, regional innovation systems, Germany, probabilistic entropy

Zusammenfassung

"Bestimmung der Wissensbasis regionaler Innovationssysteme in Deutschland anhand der Triple Helix-Dynamik"

Während eine Marktwirtschaft nach Gleichgewicht strebt, kann diese Stabilisierungstendenz in einer Wissensgesellschaft durch einen zusätzlichen Feedback-Effekt der Globalisierung gestört werden. Das Zusammenspiel der drei Teildynamiken ökonomischer Austausch, technologische Innovation und institutionelle Kontrolle kann mit einem allgemeinen Triple Helix-Model erfasst werden. Wir nutzen die gegenseitigen Informationsflüsse zwischen diesen drei Teildynamiken als einen Indikator für die systemische Integration dieser drei Bereiche. Dies probabilistische Entropy kann positiv oder negativ sein. Wir untersuchen, ob Ergebnisse einer früheren, für die Niederlande durchgeführten Studie auch auf Deutschland zutreffen. Wie in den Niederlanden erweist sich auch in Deutschland die medium-tech Industrie als wesentliche Triebkraft der regionalen Wissensbasis während die wissensintensiven Dienstleistungen offenbar weitgehend losgelöst von regionalen Gegebenheiten sind. Während auf der Ebene von Bundesländern (NUTS-1 Regionen) noch ein klarer Ost-West-Unterschied festgestellt werden kann ist das Bild auf der feineren Ebene von NUTS-2 Regionen wesentlich differenzierter.

JEL classification: C14, O18, O31, R12

Keywords: Wissensgesellschaft, Triple Helix, Regionale Innovationssysteme, Deutschland, Probabilistische Entropy

1. Introduction

One of the main ideas behind the concept of innovation *systems* is that innovation takes place both within firms and across the interfaces among institutional agents like universities, industries, and government agencies. The Triple Helix of university-industry-government relations, however, has hitherto been developed mainly as a *neo-institutional* model for studying the network arrangements among these agents (Etzkowitz *et al*., 2000; Powel & DiMaggio, 1983, 1991). Innovation systems differ in terms of how the fluxes through these networks are integrated and whether these heterogeneous fluxes (economic exchange relations, novelty production, and organizational control) provide a synergy. The networks provide the knowledge infrastructure, while the knowledge base of an innovation system is shaped as a division of innovative labor at the national and/or regional level. A *neo-evolutionary* model should capture the relations among the different functions (organized knowledge production, diffusion, and control) which operate in and on these networks as an interaction among the links. The functions have to be carried by the agents at the nodes, but one can no longer expect a one-to-one correspondence relation between functions and institutions (Etzkowitz & Leydesdorff, 2000). The synergy among the industrial structure, geographical distributions, and academic traditions can be considered crucial for the strength of an innovation system (Fritsch, 2004).

More important than the mere presence of agencies is the quality of their relations in a given configuration. Since the functions are carried by different agents and relations, one expects an uncertainty which can be measured as a probabilistic entropy. Systemic effects may occur that cannot be directly traced back to specific exchanges, but emerge more indirectly. In this study, the different functions will be modeled as subdynamics of the system. The subdynamics can be expected to communicate to a variable degree. The mutual information among these subdynamics will be proposed as an indicator for the measurement of the synergy at the systems level.

The geographical distribution is only one of the relevant dimensions of a configuration. Due to differences in the character of innovation processes, one can expect that geographical constraints have different effects on the various economic sectors such as manufacturing and knowledge-intensive services. The division of labour among corporations of various sizes (e.g, the number of SMEs in a region) can be

considered as a third determining factor. We use these three indicators (geography, technology, and firm size) and analyze their mutual information (in three dimensions) at various levels of the German system (states, regions) in order to test two hypotheses which we generated in a previous study using Dutch data (Leydesdorff *et al*., 2004):

- medium-tech manufacturing provides the backbone of the knowledge base of an economy more than high-tech;
- knowledge-intensive services (KIS) tend to uncouple the knowledge base of an economy from its geographical location.

In summary: this paper introduces a way of assessing the quality of regional innovation systems by measuring the interaction and synergy between subsystems by means of an indicator based on entropy statistics (Jakulin & Bratko, 2004). The approach is applied to the various regions of Germany. The following section first presents the conceptual basis of the study. Section 3 outlines the data and the spatial framework of the empirical analysis and section 4 presents the method. Following the general assessment of the quality of regional innovation systems (section 5) we compare results for different sub-sectors of the economy, particular high- and medium-tech manufacturing and knowledge-intensive services (section 6). Conclusions and policy implications are presented in the final section (section 7).

2. Theoretical background

Because innovation processes involve the generation *and* application of knowledge the quality of innovation systems is dependent on how the knowledge base is related to the network among the interacting agents (Foray, 2004). The network mainly provides an infrastructure to the innovation system: it facilitates and constrains exchanges of knowledge and resources. For a number of reasons such as costs and efforts for having face-to-face contact, a considerable part of these exchange relations is constrained geographically. The distribution of the technologies in a system, the industrial organization, and the geographical spread can be considered as relatively independent sources of variation. One can expect that these three sources of heterogeneity are reflected in the division of innovative labor.

It is important to note that the organization of the division of innovative labor does not necessarily require direct interaction, but can also be ‘systemic’ in nature,

steered for example by market forces. For this reason, an analysis of the direct relationships of actors in regional innovation systems such as market relations and R&D cooperation may not provide a sufficient basis for assessing the working of the system. The geographical dimension first *positions* the agents involved, economic exchange *relations* can be expected among the agents at the nodes, and thirdly the *dynamics* of knowledge-based innovations upset the tendency towards equilibrium prevailing in economic exchange systems (Schumpeter 1939/1964; Nelson & Winter, 1982). The three dimensions (figure 1) interact mutually; the knowledge base of an economy can be considered as an emerging interaction effect among the bilateral interaction terms. However, the synergy at the level of the knowledge base poses a problem for the measurement. Our research question is whether one is able to operationalize an indicator of this emerging and therefore 'elusive' order (Skolnikoff, 1993) and then also to measure the knowledge base of an economy (Carter, 1996; David & Foray, 2002).

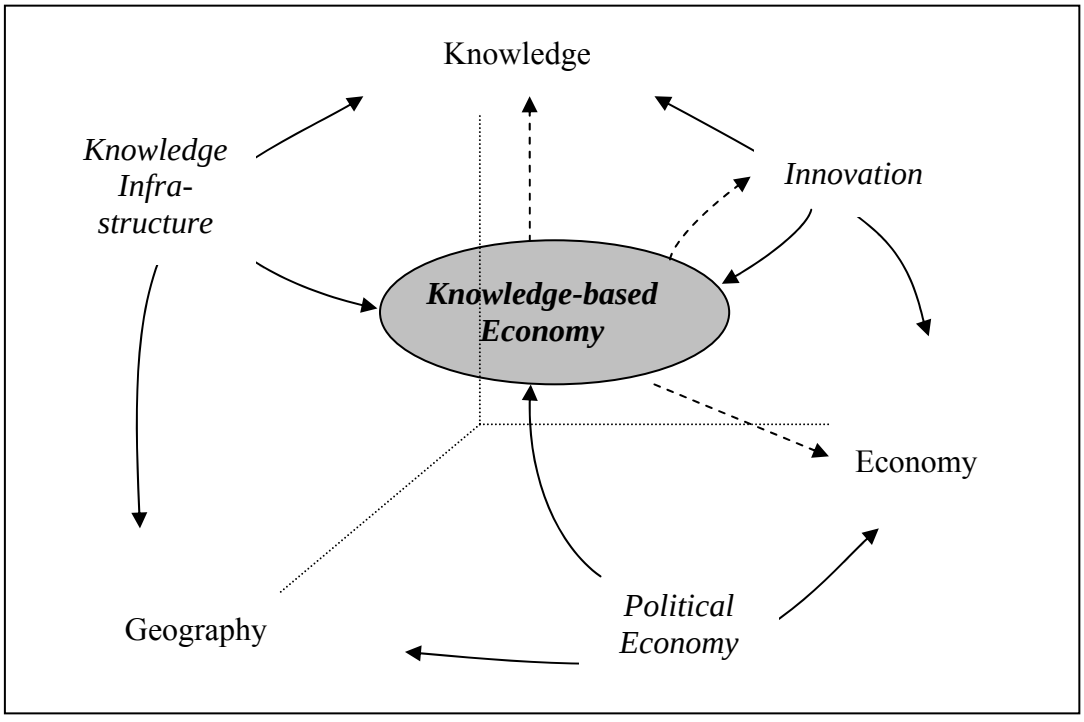

Figure 1: The interactions among sources of variation generate over time a knowledge-based economy as a three-way interaction term.

The feedback loops between the knowledge infrastructure, the prevailing regime of a political economy, and the innovative dynamics in the market can be expected to

change over time. Changes in these interactions drive cycles which can be longer-term than business cycles (Abernathy & Clark, 1985; Freeman & Perez, 1988; Schumpeter, 1939). Whether or not and to what extent a knowledge-based economy has emerged from a specific configuration of relations remains an empirical question (Nelson, 1993; Storper, 1997). In short, the knowledge infrastructure of institutional relations (e.g., among universities, industries, and governments) can be considered as a necessary but not a sufficient condition for developing a knowledge-based economy. The intensity and the quality of the interactions is decisive for the characteristics of a system.

Nations and regions can be expected to differ in combining the functional requirements of a knowledge-based economy. When a knowledge base is generated as a synergy at the systems level, one can expect the system to 'self-organize' an additional feedback loop as a dynamics at the network level. This feedback may operate positively (that is, by reducing uncertainty in the relations) or negatively because it also reinforces globalization in a previously more localized system. Etzkowitz & Leydesdorff (2000) called this additional feedback the operation of 'a network overlay' potentially emerging within a Triple Helix. In other words, the network of bilateral relations may resonate into a configuration which can be productive, innovative, and flourishing, but not all networks can be expected to do so all the time.

For example, despite their productivity, innovativeness, and the density of their relations, industrial districts and regions may suffer from deindustrialization because of the globalizing dynamics in the appropriation of the profits and the advantages of innovation (Beccatini *et al*., 2003). The *neo-institutional* perspective of social network analysis has provided us with a view of the (potentially changing) relations in the districts, but not on the dynamics. From this perspective, the emergence of a knowledge-based overlay to the system remains an unpredictable effect. The *neo-evolutionary* model analyzes the Triple Helix dynamics in terms of how these relations operate as entropy fluxes at the level of a hyper-network (Biggiero, 1998). One can expect a reduction of the uncertainty in the configuration if the overlay feeds *back* on the generation of uncertainty in the institutional relations. This decrease of the uncertainty is a consequence of the configuration of relations and cannot be attributed to the individual agents at the nodes or to specific bilateral relations.

The research question thus becomes to what degree an emerging Triple Helix dynamics is conducive to the development of specific regions and nations. Our data enables us to compare 438 districts (*Kreise*) of Germany with the conclusions from a similar study of the Netherlands (Leydesdorff *et al*., 2004). We use three proxies: (1) the geographical address for the location and therefore the relevant governance structures (i.e., districts, regions, states); (2) the three-digit code of the industry as an indicator for the technological knowledge base; and (3) average firm-size as an indicator for the organizational structure. The data enables us to cross-table these three dimensions at the district level. In the Dutch study, one of us had obtained finer-grained data at the firm level. Nevertheless, some of the conclusions from the previous study can be tested against the German data.

For example, we will be able to corroborate the conclusion that the regional differences in the configurations are determined almost exclusively by high- and medium-tech *manufacturing*. The economic benefits of knowledge-intensive *services* are not provided at the level of the regional innovation system but at the national level, while knowledge-based manufacturing tends to remain geographically embedded. Secondly, we are able to test our previous hypothesis that medium-tech manufacturing contributes more than high-tech production to the knowledge-based configuration. Corroboration of these two hypotheses has important implications for industrial development policies. Thirdly, we will compare the results for the whole of Germany with those for the former Eastern and Western parts of the country, respectively, and at the level of the Federal States (*Länder*).

3. Data

The employment and company data for this study was collected from the German Social Insurance Statistics (*Statistik der sozialversicherungspflichtig Beschäftigten*). These statistics are generated by the Federal Employment Office (*Bundesagentur für Arbeit*) (Fritsch & Brixy, 2004). In Germany, all public and private employers are required by law to register their employees with this office for enrollment in the social insurance and pension systems. In the case of composed (e.g., international) corporations with multiple locations, the data is collected at the level of the local establishments, and thus the geographical dimension is perceived in this data. However, employees who are not obliged by law to contribute to these insurance systems are (by definition) excluded

from the statistics. These include, among others, civil servants, army personnel, the self-employed, and the unemployed.[1]

The statistics were made available to us at the NUTS-3 level of the Eurostat classification of regions (Eurostat, 2003). (NUTS is an abbreviation of *Nomenclature des Unités Territoriales Statistiques*.)[2] In the German Federal Republic the NUTS-3 level coincides with the district or *Kreis*. Eurostat (2003) distinguished 440 of these districts. One of these is an unclassified category entitled 'extra region.' Two regions (Eisenach and Wartburg) have not always been distinguished in the German statistics and were merged for the purpose of this study.[3] Thus, we assume 438 districts as the units of analysis. These districts are organized in 41 regions at the NUTS-2 level which are called in German *Regierungsbezirke*. The NUTS-1 level is defined as the 16 Federal States or *Länder* that compose the German Federal Republic. Bavaria, for example, is one of these states. Figure 2 shows the organization of Germany in *Länder* and *Regierungsbezirke*, respectively. For the information of the reader, the previously East-German part of the country is shaded in figure 2a.

For historical reasons, the cities of Berlin, Hamburg, and Bremen have been considered administratively as NUTS-1 categories (*Länder*). Berlin and Hamburg consist only of single districts which are defined under the same name at the NUTS-3, NUTS-2, and NUTS-1 levels. Bremen is subdivided at the NUTS-3 level in two districts (Bremen and Bremerhaven). Other large cities, like Munich, Cologne, and Frankfurt, are defined as districts at the NUTS-3 level within their respective regions and states. For the purpose of this study, we decided to modify the data by adding Berlin as a district (at the NUTS-3 level) to Brandenburg – South-East (NUTS-2: DE42), Hamburg to the region Schleswig-Holstein (NUTS-2: DEF0), and the two districts Bremen and Bremerhaven to the region of Lüneburg (NUTS-2: DE93). At the NUTS-1 level Berlin

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[1] In manufacturing, the Social Insurance Statistics cover more than 90 percent of all employees. In the service sector, this share is about 80 percent. Coverage is relatively low in agriculture (less than 24 percent) and in the public sector (about 50 percent).

[2] The Nomenclature of Territorial Units for Statistics (NUTS) was established by Eurostat more than 25 years ago in order to provide a single uniform breakdown of territorial units for the production of regional statistics for the European Union; at http://europa.eu.int/comm/eurostat/ramon/nuts/introduction_regions_en.html

[3] The two districts 16056 (the city of Eisenach) and 16063 (the district Wartburg) have been distinguished administratively only since 1998. They are considered in this study as a single unit because the comparisons along the time line which we envisage in future studies.

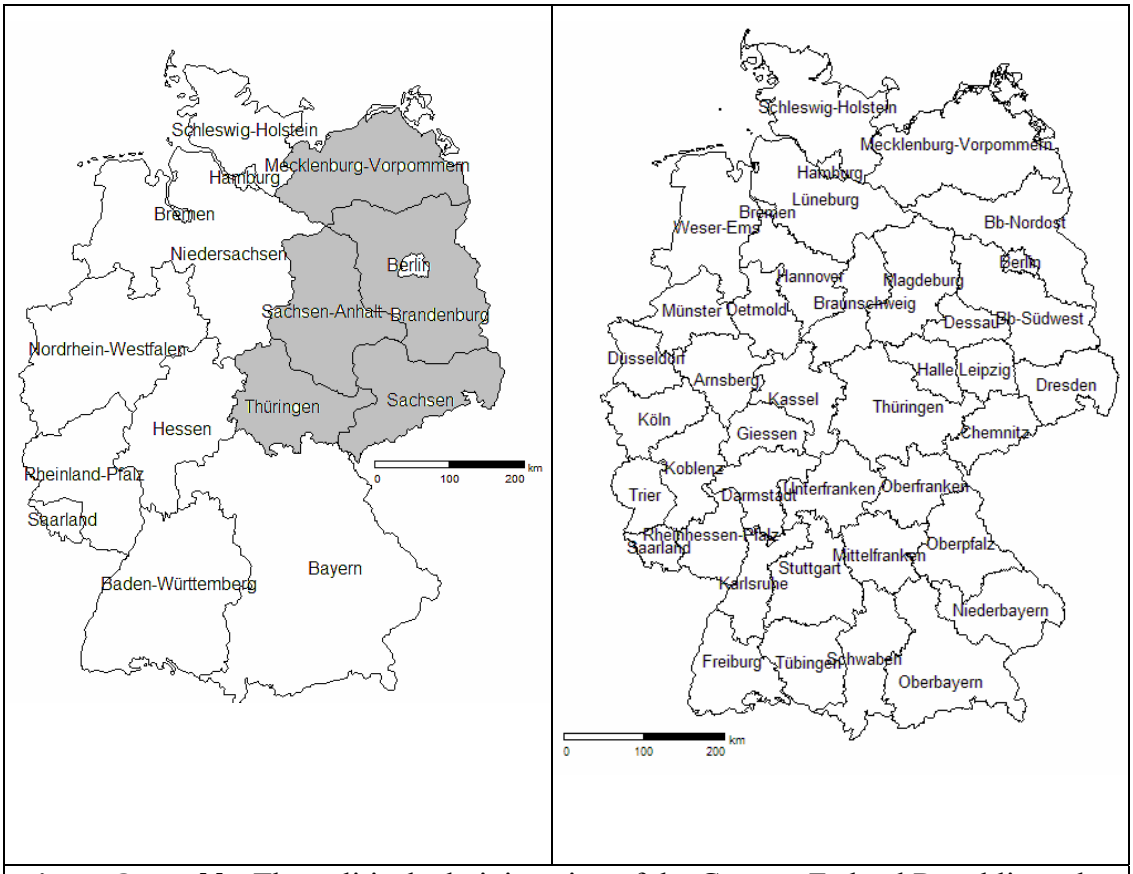

Figure 2a and b: The political administration of the German Federal Republic at the NUTS-1 (*Länder*) and NUTS-2 (*Regierungsbezirke*) levels, respectively.

will thus be considered as part of Brandenburg (DE4), Hamburg as part of Schleswig-Holstein (DEF), and Bremen/Bremerhaven belongs to Lower Saxony (DE9).

The German Federal Office for Building and Regional Planning (*Bundesamt für Bauwesen und Raumordnung*; BBR, 2002) has attributed categories to these districts according to the scheme shown in table 1. Not surprisingly, this classification is negatively correlated with the population density (population/area) of the districts at the level of Spearman's $\rho = -.67$ ($p < 0.01$; $N = 438$). The category numbers do not necessarily indicate ranks in a spatial hierarchy, since some core cities of the urbanized regions (class 5) can be ranked higher in a hierarchy than the rural districts of the agglomerations (class 4). However, we will not use this classification as a rank order, but as a scheme only in order to generate a distribution containing an uncertainty in the

geographical dimension.[4] Although we could have used population density as a classifier, we considered this informed classification as the better choice.

Table 1: Classification of districts into district types

Type of district	Classification number	Number of districts
Agglomerations		
Core cities	1	43
Districts with high density	2	44
Districts with average density	3	39
Rural districts	4	23
Urbanized regions		
Core cities	5	29
Districts with average density	6	91
Rural districts	7	68
Rural areas		
Rural districts with relatively high density	8	58
Rural districts with relatively low density	9	43
		N = 438

In addition to information at the level of each district, such as the population and the size of the district, our data contains the numbers of establishments and employees in each district at the three-digit level of the NACE classification.[5] Since various sectors of the economy can be expected to use different technologies, the sector classifications can be used as a proxy for the technology (Pavitt, 1984). The OECD (2001: 137ff.) indicated the various sectors in terms of their knowledge intensity at the two-digit level of the NACE code as provided in table 2. The 222 NACE categories present in our data are available at the three-digit level; these can be subsumed under 60 NACE categories at the two-digit level. We use the information at the three-digit level for the computation, but the two-digit level for making appropriate selections according to the definitions of the OECD and Eurostat.

[4] The geographical units themselves are unique and, therefore, do not contain uncertainty.
[5] NACE stands for *Nomenclature générale des activités économiques dans les Communautés Européennes*. The NACE code can be translated into the so-called International Standard Industrial Classification.

Table 2: Classification of high-tech and knowledge-intensive sectors according to the OECD and Eurostat (Source: Laafia, 2002: 7).

High-tech Manufacturing	*Knowledge-intensive Sectors (KIS)*
30 Manufacturing of office machinery and computers **32** Manufacturing of radio, television and communication equipment and apparatus **33** Manufacturing of medical precision and optical instruments, watches and clocks *Medium-high-tech Manufacturing* **24** Manufacture of chemicals and chemical products **29** Manufacture of machinery and equipment n.e.c. **31** Manufacture of electrical machinery and apparatus n.e.c. **34** Manufacture of motor vehicles, trailers and semi-trailers **35** Manufacturing of other transport equipment	**61** Water transport **62** Air transport **64** Post and telecommunications **65** Financial intermediation, except insurance and pension funding **66** Insurance and pension funding, except compulsory social security **67** Activities auxiliary to financial intermediation **70** Real estate activities **71** Renting of machinery and equipment without operator and of personal and household goods **72** Computer and related activities **73** Research and development **74** Other business activities **80** Education **85** Health and social work **92** Recreational, cultural and sporting activities Of these sectors, **64, 72** and **73** are considered *high-tech services*.

Table 3: Distribution of company sizes in the German data.

Number of employees	Frequency	Percent	Cumulative Percent
1	4721	7.0	7.0
2 to 4	16117	24.0	31.0
5 to 9	17416	25.9	56.9
10 to 19	12690	18.9	75.7
20-49	9745	14.5	90.2
50-99	3501	5.2	95.4
100-199	1775	2.6	98.1
200-499	912	1.4	99.4
500-749	186	.3	99.7
750-999	70	.1	99.8
> 1000	132	.2	100.0
	67265	100.0	

For reasons of comparison with the Dutch study (Leydesdorff *et al*., 2004), we used the same classification for the average establishment sizes (table 3). Average firm size in terms of numbers of employees can be used as a proxy for the industrial organization (Pugh *et al*., 1969a, 1969b; Blau & Schoenherr, 1971). The Dutch data

included a category for firms with zero employment, but this category is not contained in the German statistics because self-employed persons are not obliged to contribute to the social insurance scheme. In summary, the maximum entropy of the system under study is determined by 222 NACE categories, 9 district types, and 11 size categories of establishments, that is, $H_{max} = {}^2\log (222 * 9 * 11) = 14.42$ bits of information.

4. Methods

In general, two interacting systems (or variables) determine each other in their mutual information and condition each other in the remaining uncertainty. They reduce the uncertainty on either side with the mutual information or the transmission (T).[6] Using Shannon's formulas, this transmission can be defined as the difference between the sum of the uncertainty in these systems without the interaction ($H_x + H_y$) minus the uncertainty prevailing when the two systems are combined (H_{xy}). This can be formalized as follows:

$$T_{xy} = (H_x + H_y) - H_{xy} \qquad (1)$$

H_x is the uncertainty in the distribution of the variable *x* (that is, $H_x = -\sum_x p_x {}^2\log p_x$), and analogously, H_{xy} is the uncertainty in the two-dimensional probability distribution (matrix) of *x* and *y* (that is, $H_{xy} = -\sum_x \sum_y p_{xy} {}^2\log p_{xy}$). In the case of two dimensions, transmission reduces the uncertainty in the two interacting dimensions (*x* and *y*) with the mutual information ($T_{xy} \geq 0$), and therefore $H_{xy} \leq H_x + H_y$.[7] Because of the sigma in the formulas, all information terms can be fully decomposed (Theil, 1972). If base two is used for the logarithm, all values are expressed in bits of information. Note that these measures are formal (probability) measures and thus independent of size or any other reference to the empirical systems under study.

Abramson (1963: 129) derived from the Shannon formulas that the mutual information in three dimensions is:

$$T_{xyz} = H_x + H_y + H_z - H_{xy} - H_{xz} - H_{yz} + H_{xyz} \qquad (2)$$

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[6] The transmission can be considered as an information-theoretical equivalent of the covariance as a measure of the covariation. The covariation is only a part of the total variation in each of the covarying dimensions. Unlike the covariance, the mutual information can be provided with an interpretation in the case of more than two dimensions and with a dynamic interpretation so that a coevolution can also be measured (Leydesdorff, 1995).

[7] In the limiting case that the distributions *x* and *y* are completely independent, $T_{xy} = 0$ and $H_{xy} = H_x + H_y$.

While the bilateral relations between the variables reduce the uncertainty, the trilateral term in turn feeds back on this reduction, and therefore adds another term to the uncertainty. The layers thus alternate in terms of the sign. This alteration can be generalized for more than three dimensions, but for reasons of parsimony we limit the discussion here to three dimensions.

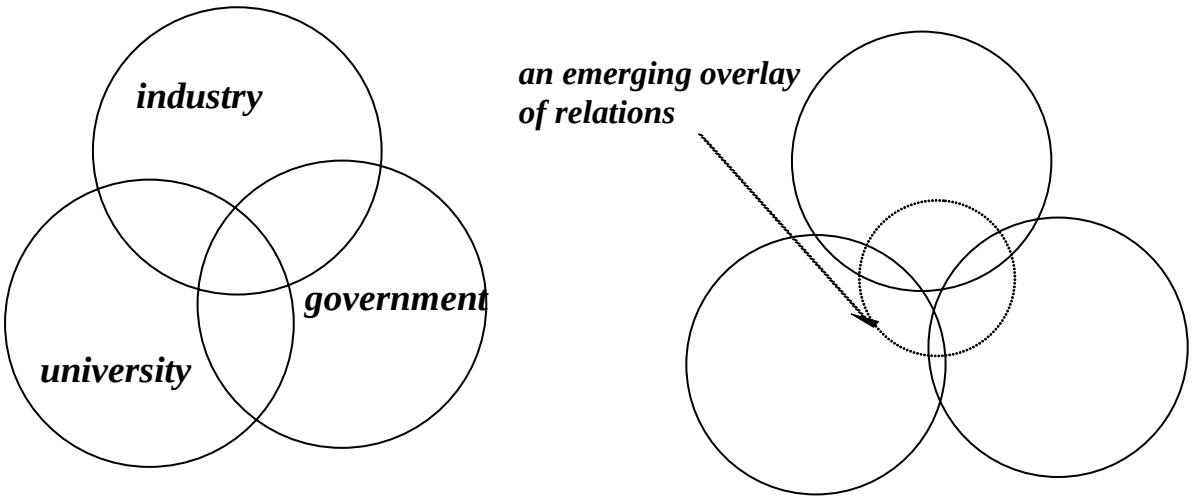

Figure 3a and b: The neo-institutional and the decentralized (neo-evolutionary) variants of the Triple Helix model

When the three Venn diagrams (in figure 3a) overlap in a common intersection, the mutual information in three dimensions can be positive because the H_{xyz} outweighs the negative terms of the bilateral relations. When bilateral relations prevail (figure 3b), a negative entropy can be generated because the positive contribution of the H_{xyz} is lacking. In this configuration, the trilateral integration in a center tends to be absent. If the bilateral relations resonate into the productive configuration of an overlay, this network structure can feed back on the uncertainty prevailing in the network system without control by an agent at the center (cf. Guston, 2000; Van der Meulen, 1998). Such a decentralized system has the evolutionary advantage that it can process more complexity than a centralized system. In general, a system without centrally controlled *integration* reduces uncertainty by providing a rather *differentiated configuration*. The puzzles of integration at the interfaces have then to be solved locally by agents which reach across the boundaries of otherwise uncertain (because evolving) subsystems.

The value of T_{xyz} measures the interrelatedness of the various sources (x, y, z) and the intensity of the relations between and among them. It can, therefore, be considered as an indication of the intensity and the quality of innovative labor division in a broad sense. Assuming that a division of labor can yield efficiency gains, one would expect that regions with a profiled configuration are more productive than regions with a lower level of 'puzzle-solving' in the division of labor. In other words, this indicator does *not* measure the innovative activity or economic output of a system (Carter, 1996). It measures only the conditions in the system for innovative activities, and thus specifies an expectation. However, regions with a high potential for innovative activity can be expected to organize more innovative resources than regions with lower values of the indicator.

5. Results

Figure 4 shows the results of the computations using the specification of the data and methods above for the whole of Germany, aggregated at both the NUTS-1 level (*Länder*) and the NUTS-2 level of *Regierungsbezirke*. The left-hand figure (at the NUTS-1 level) exhibits the different dynamics in the former eastern and western parts of the country. This is not surprising given the need for radical reorganization of the East-German innovation system after unification. The socialist type of innovation regime that existed in the former German Democratic Republic until the fall of the Iron Curtain in 1989 was so different from a market-based system that the transition between these two regime types can be expected to take considerable time (Fritsch & Werker, 1999). It is, however, remarkable that the weakest knowledge base is found for the West-German region of Saarland, and that the East-German NUTS-1 level unit Saxony seems already to perform better on this indicator than the West-German state of Schleswig-Holstein (table 4).

The right-hand figure (at the NUTS-2 level) shows a more differentiated picture. The function of the metropolitan areas of Munich and Hamburg is highlighted. The decomposition at the NUTS-2 level shows that in addition to Saarland the regions of Trier, Gießen, Freiburg, and Tübingen have similarly low values in the western part of Germany. In East Germany the weakest knowledge base is found in rather sparsely populated Northeast Brandenburg, as well as in the neighbouring regions of Leipzig,

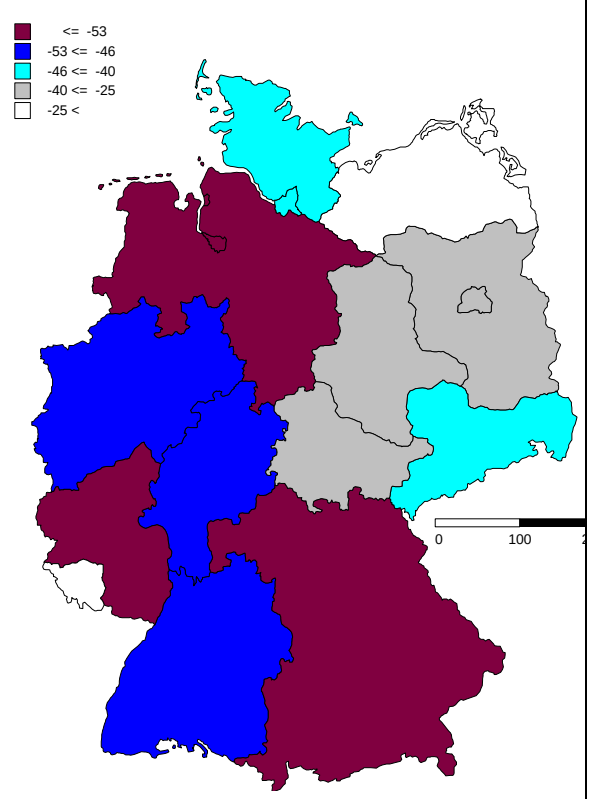

Figure 4a: The mutual information in three dimensions at the NUTS-1 level

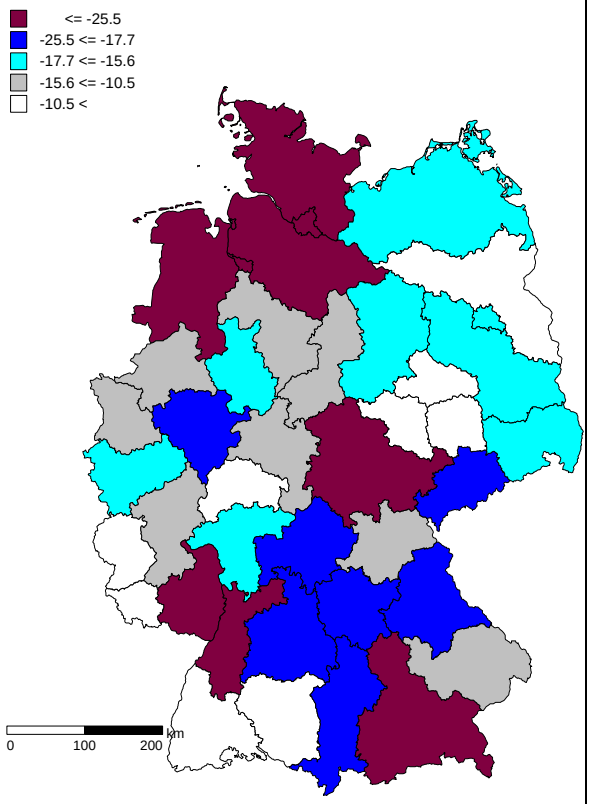

Figure 4b: Idem at the NUTS-2 level.

Halle, and Dessau. While the region of Northeast Brandenburg is nearly devoid of R&D resources, the regions of Leipzig, Halle, and Dessau are old industrialized areas in which the need for radical change has been particularly strong.

The two pictures are based on different normalizations because the contributions of regions are weighed in terms of the number of districts at the respective level of aggregation, but with reference to the values for Germany as a whole. The districts (at the NUTS-3 level) are our units of analysis, and the NUTS-2 level and the NUTS-1 level are levels of aggregation. In addition to the aggregation, however, one would also expect in-between group interaction effects among the higher-order units at the national level. Given the different normalizations at the NUTS-2 or NUTS-1 level, the two representations cannot be compared in terms of the absolute values of the indicator.

Table 4: The mutual information in three dimensions statistically decomposed at the NUTS-1 level of the German states (*Länder*).

NUTS 1 (Länder)	T_{GTO} in mbits before normalization	ΔT_{GTO} (= n_i * T_i /N) in mbits of information	n_i
Baden-Württemberg	-474.91	-47.71	44
Bavaria	-412.48	-90.41	96
Brandenburg	-583.86	-25.33	19
Hesse	-778.93	-46.24	26
Mecklenburg-Western Pomerania	-430.28	-17.68	18
Lower Saxony	-632.35	-69.30	48
North Rhine-Westphalia	-404.10	-49.82	54
Rhineland-Palatinate	-647.76	-53.24	36
Saarland	-639.67	-8.76	6
Saxony	-649.83	-43.03	29
Saxony-Anhalt	-600.14	-32.88	24
Schleswig-Holstein	-1102.75	-40.28	16
Thuringia	-619.48	-31.12	22
Germany	-180.08	-180.08	438

For example, the states of Schleswig-Holstein (formerly part of Western Germany) and Mecklenburg-Western Pomerania (formerly part of Eastern Germany) are equally defined at the NUTS-1 and the NUTS-2 level, and thus these units are comparatively large when compared with other regions in the right-hand picture, while the same values are compared with the other states in the left-hand figure. In both figures, the contribution of each part of the country is normalized with reference to the country (that is, Germany; N = 438) as the baseline using $\Delta T_{GTO} = n_i * T_i /N$. Since the districts are our units of analysis, n_i in this formula stands for the number of districts in the unit under study and T_i for the mutual information in the three dimensions (G)eography, (T)echnology, and (O)rganization at this level of aggregation. Table 4 provides these values for the *Länder* (that is, at the NUTS-1 level). At the NUTS-2 level the values for n_i are lower except for those NUTS-1 level units which are not further decomposed (e.g., Schleswig-Holstein and Mecklenburg-Western Pomerania). The values at the NUTS-2 level are provided in the Appendix.

Unlike our previous results for the Netherlands, the value of the indicator for Germany as a whole is less negative then the sum of the values for the *Länder*. This

means that there is configurational synergy at the local levels of NUTS-1 and NUTS-2 which is no longer retrieved when the distributions are aggregated at the national level. The negative entropy is a local attribute. When decomposed, the additional synergy is generated mainly by the mutual information between the NACE-codes and the size categories of the business. The type of district (rural versus urban) has less influence on the potential synergy than the interplay between the organizational format and the technological structure of the industry.

Should perhaps the Netherlands as a country rather be compared with the separate states of the Federal Republic? We are not able to answer this question on the basis of the data because the results for the Netherlands were based on micro-data, and we did not use a characterization of the districts in rural, urban, etc., but only the postal codes. However, Figure 5 shows the results of limiting the analysis to Bavaria as an example of such a lower-level decomposition at the level of a state.

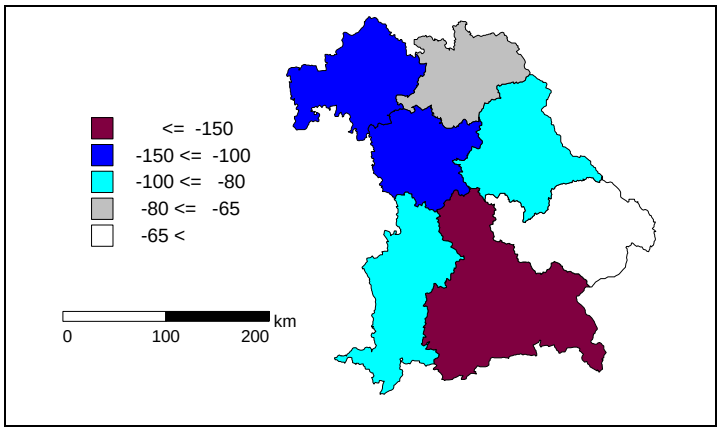

Figure 5: The mutual information in three dimensions normalized for the seven NUTS-2 regions (*Regierungsbezirke*) of Bavaria.

The picture that we obtain in our analysis for Bavaria (figure 5) corresponds particularly well with the commonly assumed quality of the innovation system in the different regions of this state. Unfortunately, information about the quality of regional innovation systems is hitherto available only for certain regions, often in the form of case studies that do not allow for a systematic interregional assessment and comparison with our indicator. According to such case studies the innovation system of the Munich region has been said to be highly productive in recent times (Sternberg & Tamasy,

1999; Krauss & Wolff, 2002), while the Ruhr area and some of the East-German regions are lagging behind, with the exception of Saxony and Thuringia. This corresponds with our findings at the NUTS-2 level (figure 4b).

The pronounced position of the metropolis of Munich in figure 5 contrasts with the lowest rank for the innovation system in the region of Lower Bavaria (east of Munich) which has a reputation for being characterized by a low level of dynamics. This region, as well as Upper Palatinate and Upper Franconia, were located on the border with the Czech Republic and the former German Democratic Republic, respectively. The Iron Curtain that divided Eastern and Western Europe for a long period of time may have left a longer lasting imprint on these regions. Particularly Upper Franconia is peripheral and distanced from any larger centre. The region of Middle Franconia contains Nuremberg, the second largest city of the state of Bavaria, while the region of Lower Franconia is adjacent to the dynamic Frankfurt area. According to our calculations, both regions are in the second highest category. One may assume that Swabia draws some benefits from its geographical closeness to Munich and to Nuremberg so that it maintains a middle-range position.

6. The sectorial decomposition in terms of the knowledge base

As noted, one main purpose of this article was to test two hypotheses which resulted from a previous study of the knowledge base of the Dutch economy. These two results were:

- Medium-tech manufacturing generates more configurational information in a geographical unit than high-tech establishments;
- Knowledge-intensive services uncouple the knowledge base from its geographical location, while high- and medium-tech manufacturing remain geographically embedded.

The interpretation of these two findings could be that the sectors assume different roles in the division of innovative labor. Medium-tech businesses can be expected to focus on maintaining absorptive capacity, so that knowledge and technologies developed elsewhere can be understood more easily and adapted to local circumstances (Cohen & Levinthal, 1989). From the perspective of the organization of technological knowledge, high-tech manufacturing may be focused on (internal) production within the

transnational corporation, take place as spin-offs of research institutions, and involve global markets more than local environments. From the industrial perspective, one could, therefore, assume that medium-tech manufacturing functions as a seedbed for high-tech production.

The knowledge-intensive services can be expected to uncouple from the geographical location more easily than manufacturing because these services can be offered across regional boundaries, for example, by using communication media or by traveling of the consultants. It is not uncommon for knowledge-intensive services to be offered on the site of the customer by someone brought in from elsewhere. Unlike manufacturing, knowledge-intensive services can be offered throughout the country and abroad without necessary links to local production facilities like factories. Thus, the geographical location can be chosen by these firms on grounds different from the local configuration in terms of the Triple Helix dimensions. Note that this reasoning can be expected to hold less for knowledge-intensive sectors which are also high-tech, because in this case a local production component (e.g., R&D laboratories) may be needed for support.

Table 5 compares the relevant numbers of units (e.g., establishments) with the respective NACE categories as provided in table 2 above. While in the Netherlands 51.3% of the establishments were knowledge-intensive services, this percentage is only 33.2% for Germany. Note that in accordance with the OECD/Eurostat classifications the high-tech services are considered as a subclass of knowledge-intensive services, while high- and medium-tech manufacturing are considered as two different classes. The ratio between high- and medium-tech manufacturing establishments is 23,912/39,281 = 0.61 for Germany versus 4,126/11,712 = 0.35 for the Netherlands.[8] This confirms that Germany is relatively more high-tech in manufacturing, while less knowledge-intensive in the service sectors.

[8] Unfortunately, the Dutch data does not allow us to make this comparison in terms of the numbers of employees in the different sectors because the respondents indicated only the size categories. However, more than 71.8% of the high-tech manufacturing has a size smaller than five employees, while this is only 61.2% for medium-tech. For Germany, the ratio of 663,210 employees in medium tech versus 2,820,436 in high tech is 0.23.

Table 5: The distribution of records and establishments in the database across sectors given different selections using NACE codes.

2002	Number of records	Number of establishments	Number of employees	NACE categories
All sectors	67,265	2,119,028	27,596,100	
High-tech manufacturing	2,606 *3.9%*	23,912 *1.1%*	663,210 *2.4%*	30, 32, 33
Medium-tech manufacturing	7,127 *10.6%*	39,281 *1.9%*	2,820,436 *10.2%*	24, 29, 31, 34, 35
Knowledge-intensive services	17,271 *25.7%*	703,817 *33.2%*	9,619,657 *34.9%*	61, 62, 64, 65, 66, 67, 70, 71, 72, 73, 74, 80, 85, 92
High-tech services	3,097 *4.6%*	45,485 *2.1%*	817,305 *3.0%*	64, 72, 73

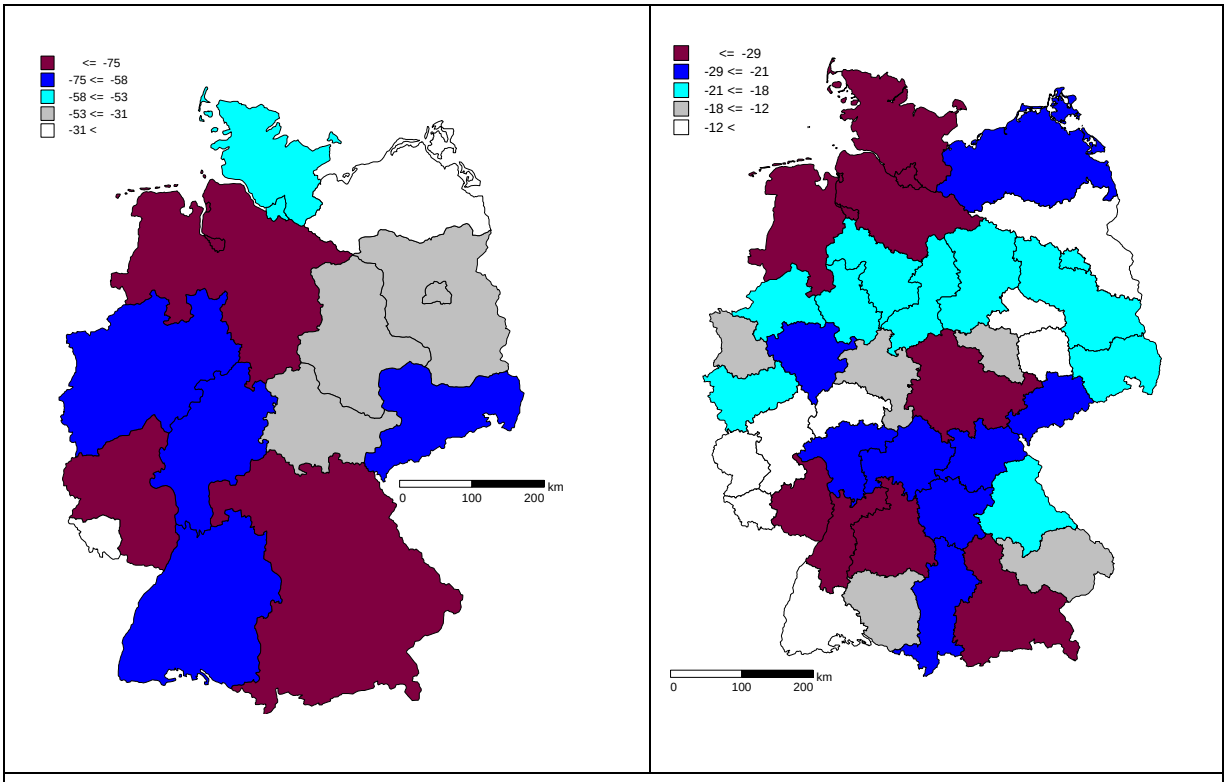

Figure 6a and b: Medium-tech manufacturing generates the knowledge base in Germany.

Figure 6 provides visualizations of the results when the analysis is limited to medium-tech manufacturing, that is, approximately 1.9 % of the total number of establishments included in the data. The pictures are virtually similar to those in figure 4 which were based on 100% of the data. As expected, some regions are ranked higher

when we focus on this selection, but the pattern is the same. In other words, the quality of the regional innovation system is more or less completely determined by medium-tech manufacturing. The tables in the Appendix teach us that the high-tech manufacturing reduces the (negative) configurational information more often than not, while the effects of medium-tech always make the configurational information more negative. Therefore, the configuration of medium-tech manufacturing can be considered a better indicator of the knowledge-based economy than that of high-tech manufacturing.

The relation between high- and medium-tech manufacturing thus exhibits the patterns that were predicted on the basis of the study for the Netherlands. With the exception of Mecklenburg-Western Pomerania, the configurational information gain is always larger for medium-tech than for high-tech manufacturing at the NUTS-1 level. At the NUTS-2 level high-tech manufacturing provides a decrease of the configurational information in 26 of the 38 regions, while medium-tech manufacturing always increases the reduction of the prevailing uncertainty. These effects are not specific for the western or eastern parts of Germany.

The tables in the Appendix further teach us that knowledge-intensive services *always* have the effect of making the configurational information less pronounced. With the single exception of Hesse, all states (at the NUTS-1 level) are further coupled geographically when from the knowledge-intensive services only the high-tech ones are selected. For Mecklenburg-Western Pomerania and Saxony-Anhalt (both parts of the former GDR) these couplings even become a contribution to the configurational information. At the NUTS-2 level, such a contribution of high-tech services is also found in certain West-German regions (e.g., Koblenz), but this effect is more pronounced in East-German regions like Magdeburg.

Table 6 expresses these conclusions in quantitative terms by using the respective variances as a measure. The variances clearly show that the levels of regional difference are considerably smaller for high-tech manufacturing than for medium-tech manufacturing, but as we have seen above both have a structuring effect on the economy. The knowledge-intensive services do not contribute to structuring the

Table 6: Variances in the ΔT across knowledge-based sectors of the economy at the NUTS-1 and NUTS-2 levels

	NUTS-1	NUTS-2
All sectors	458.277	83.763
knowledge intensive services	256.176	57.624
high-tech services	357.369	75.007
medium-tech manufacturing	1133.959	161.110
high-tech manufacturing	744.390	91.898
high & medium-tech manufacturing	1058.008	106.112
Number of regions	13	38

knowledge-based economy differently among regions, but this is less the case at the high-tech end of these services. As noted, this latter effect is enhanced in less-developed regions like Eastern Germany.

7. Conclusions and policy implications

Our analyses indicate that the federal structure of Germany makes the states (*Länder*) probably a more important unit of analysis in studying the knowledge-based economy than the Federal Republic as a whole. This suggests that innovation processes have a regional dimension. Using the mutual information in three dimensions as an indicator, we were able to reproduce the former division of the country between East and West at the NUTS-1 level of the states, but at the lower (NUTS-2) level of regions (*Regierungsbezirke*) the picture has in the meantime become more complex. We indicated several dynamics which are different for East and West—for example, the function of high-tech knowledge-intensive services seems to function more locally in the Eastern part of Germany—but we also note a further merging together of the two parts of the country in terms of its knowledge-based dynamics. One should keep in mind that globalization and the emergence of a knowledge-based economy itself were partly effects of the demise of the Soviet Union and the subsequent integration of Germany (Leydesdorff, 2000).

The Netherlands have been a nation state since the time of Napoleon. Nevertheless, we found as much variation in the Netherlands as in Germany in terms of the mutual information among technology indicators, business indicators, and geographical locations. One technical reason for this is, perhaps, that the data for the Netherlands was finer-grained than for Germany. From the perspective of evolution

theory, however, an emerging feedback operating as an additional selection mechanism, can be expected to produce a skewed distribution in the underlying variation. Thus, one can expect that some regions will tend to become more knowledge-based in their economy than others despite efforts by national and regional governments to redistribute resources proportionally (Danell & Persson, 2003). In an increasingly globalized environment, mechanisms other than political control thus become more important than traditional policies (Bathelt, 2003; Cooke & Leydesdorff, 2005). The non-equilibrium dynamics of the knowledge-based economy can be expected to counteract the equilibrium-seeking mechanisms of the market and the quasi-equilibrium of redistribution by institutional policies (Aoki, 2001).

We have argued that the dynamics of technological innovation can be expected to add a third subdynamics to the political dynamics of institutionalization and regulation, and the equilibrating forces of the market (Leydesdorff & Meyer, 2003). This interaction among three subdynamics can be captured by using the evolutionary version of the Triple Helix model and then be measured using the mutual information among these subdynamics. The mutual information in three dimensions can also be considered as the configurational information (McGill, 1954; Jakulin & Bratko, 2004). The results of our measurements using this indicator confirmed the hypothesis that the quality of a regional innovation system is determined almost entirely by medium- and high-tech manufacturing. Actually, the contribution of medium-tech manufacturing to the configuration can be used as a predictor of the properties of the innovation system in a given region. High-tech manufacturing adds to the pattern, but the size of high-tech manufacturing is small and the relative effect is also small. Because high-tech is so thinly spread across the country, its distribution may be more specific than for larger sectors.

Knowledge-intensive services seem to be largely uncoupled from the configuration within a regional or local economy. They contribute negatively to the knowledge-based configuration because of the inherent capacity of the service providers to deliver these services outside the region. Thus, a locality can be chosen on the basis of considerations other than those relevant for the generation of a knowledge-based economy in the region. For example, the proximity of a well-connected airport (or train station) may be a major factor in the choice of a location. This conclusion of the

globalizing effect of knowledge-intensive services holds true for all regions both in the Netherlands and in Germany.

The high-tech component of the knowledge-intensive services sometimes exhibits a coupling with the regional economy. This effect was particularly strong in some of the formerly East-German regions (e.g., Dessau, Magdeburg, Mecklenburg, and Western Pomerania). However, given the prevailing pattern in more developed parts of the economy, this effect may disappear in the longer run because it may be specific to the developmental stage of the economy in these parts of Eastern Germany. Note that the non-localized character of knowledge-intensive services does not necessarily mean that they are unimportant for a regional innovation system. In addition to providing potentially high-quality employment, knowledge-intensive service providers that operate at an inter-regional level may be an important medium for knowledge spillovers across regions.

In many countries innovation policy has been focused on high-tech. According to our findings, medium-tech is at least as important for the local quality of the knowledge-based economy. This suggests that the high-tech focus is not justified for development policies. Insofar as one attracts knowledge-intensive services, however, these services should be stimulated at the high-tech end. Unlike knowledge-intensive services, high-tech services seem to have reinforcing effects on the configurational information. Note that these appreciations do not imply that one should not pay attention to other sectors of the economy—for example, in order to stimulate employment—but one cannot expect these other sectors to contribute significantly to the knowledge base of a regional economy. The effects of these businesses can be expected to contribute equally well to the larger environment.

Our analyses suggest that regional conditions for innovation processes are rather heterogeneous, and that innovation processes have a pronounced regional dimension. Policy should consider this regional dimension of innovation processes and might, therefore, be regionalized. This means that innovation policy should operate to a considerable degree at the regional level, so that measures can be adjusted to regional specifics. This could also mean political decentralization, i.e., that decision competencies concerning policy measures should be regionalized and that at least some financial resources should be raised locally (see Fritsch & Stephan, 2005).

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References

Abernathy, W. J., & K. B. Clark. (1985). Innovation: Mapping the Winds of Creative Destruction. *Research Policy,* 14, 3-22.

Abramson, N. (1963). *Information Theory and Coding*. New York, etc.: McGraw-Hill.

Aoki, M. (2001). *Towards a Comparative Institutional Analysis*. Cambridge, MA: MIT Press.

Bathelt, H. (2003). Growth Regimes in Spatial Perspective 1: Innovation, Institutions and Social Systems. *Progress in Human Geography,* 27(6), 789-804.

Beccatini, G., M. Bellandi, G. D. Ottati, & F. Sforzi. (2003). *From Industrial Districts to Local Development: An Itinerary of Research*. Cheltenham, UK; Norhhampton, MA: Edward Elgar.

Biggiero, L. (1998). Italian Industrial Districts: A Triple Helix Pattern of Problem Solving. *Industry and Higher Eductation,* 12(4), 227-234.

Blau P. M. & R. Schoenherr (1971). *The Structure of Organizations*. New York: Basic Books.

Carter, A. P. (1996). Measuring the Performance of a Knowledge-Based Economy. In D. Foray & B. A. Lundvall (Eds.), *Employment and Growth in the Knowledge-Based Economy*. Paris: OECD.

Cohen, W. M., Levinthal, D. A. (1989). Innovation and Learning: The two faces of R&D, *The Economic Journal,* 99, 569-596.

Cooke, P., & L. Leydesdorff. (2005). Regional Development in the Knowledge-Based Economy: The Construction of Advantages. *Journal of Technology Transfer,* 30(3), forthcoming.

Danell, R., & O. Persson. (2003). Regional R&D Activities and Interaction in the Swedish Triple Helix. *Scientometrics,* 58(2), 205-218.

David, P. A., & D. Foray. (2002). An Introduction to the Economy of the Knowledge Society. *International Social Science Journal,* 54 (171), 9-23.

Etzkowitz, H., & L. Leydesdorff (2000). The Dynamics of Innovation: From National Systems and 'Mode 2' to a Triple Helix of University-Industry-Government Relations. *Research Policy*, 29 (2), 109-123.

Etzkowitz, H., A. Webster, C. Gebhardt, & B. R. C. Terra. (2000). The Future of the University and the University of the Future: Evolution of Ivory Tower to Entrepreneurial Paradigm. *Research Policy,* 29(2), 313-330.

Eurostat (2003). Regulation (EC) No 1059/2003 of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS). *Official Journal of the European Union,* L 154, 21/06/2003; at http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_154/l_15420030621en00010041.pdf .

Federal Office for Building and Regional Planning (Bundesamt für Bauwesen und Raumordnung) (2002) *Aktuelle Daten zur Entwicklung der Städte, Kreise und*

Gemeinden, Ausgabe 2002, Berichte, Band 14, Bonn: Federal Office for Building and Regional Planning.

Foray, D. (2004). *The Economics of Knowledge*. Cambridge, MA/ London: MIT Press.

Freeman, C. & C. Perez (1988). Structural Crises of Adjustment, Business Cycles and Investment Behaviour. In G. Dosi, C. Freeman, R. N. G. Silverberg & L. Soete (Eds.), *Technical Change and Economic Theory* (pp. 38-66). London: Pinter.

Fritsch, M. (2004). R&D-Cooperation and the Efficiency of Regional Innovation Activities, *Cambridge Journal of Economics*, 28 (2004), 829-846.

Fritsch, M., & U. Brixy (2004). The Establishment File of the German Social Insurance Statistics, *Schmollers Jahrbuch / Journal of Applied Social Science Studies,* 124, 183-190.

Fritsch, M. & A. Stephan (2005). Regionalization of Innovation Policy – Introduction to the Special Issue, *Research Policy*, 34 (forthcoming).

Fritsch, M. & C. Werker (1999). Systems of Innovation in Transition. In M. Fritsch & H. Brezinski (Eds.), *Innovation and Technological Change in Eastern Europe – Pathways to Industrial Recovery* (pp. 5-22). Cheltenham: Edward Elgar.

Guston, D. (2000). *Between Politics and Science*. Cambridge, UK, etc.: Cambridge University Press.

Jakulin, A., Bratko, I. 2004. *Quantifying and Visualizing Attribute Interactions: An Approach Based on Entropy*, from http://arxiv.org/abs/cs.AI/0308002

Krauss, G., & H.-G. Wolff. (2002). Technological Strengths in Mature Sectors--an Impediment of an Asset of Regional Economic Restructuring? The Case of Multimedia and Biotechnology in Baden-Württemberg. *Journal of Technology Transfer,* 27(1), 39-50.

Laafia, I. (2002). Employment in High Tech and Knowledge Intensive Sectors in the EU Continued to Grow in 2001. *Statistics in Focus: Science and Technology,* Theme, 9(4), at http://europa.eu.int/comm/eurostat/Public/datashop/print-product/EN?catalogue=Eurostat&product=KS-NS-02-004-__-N-EN&mode=download .

Leydesdorff, L. (1995). *The Challenge of Scientometrics: The Development, Measurement, and Self-Organization of Scientific Communications*. Leiden: DSWO Press, Leiden University; available at http://www.upublish.com/books/leydesdorff-sci.htm [Retrieved on 12 December 2004].

Leydesdorff, L. (2000). Is the European Union Becoming a Single Publication System? *Scientometrics,* 47(2), 265-280.

Leydesdorff, L., W. Dolfsma & G. van der Panne (2004). Measuring the Knowledge Base of an Economy in terms of Triple Helix Relations among 'Technology, Organization, and Territory,' Paper presented at the *10th Annual Meeting of the International Joseph A. Schumpeter Society*, Milan, 10-12 June 2004.

Leydesdorff, L., & M. Meyer. (2003). The Triple Helix of University-Industry-Government Relations: Introduction to the Topical Issue. *Scientometrics,* 58(2), 191-203

McGill, W. J. (1954). Multivariate Information Transmission. *Psychometrika,* 19(2), 97-116.

Nelson, R. R. (Ed.). (1982). *Government and Technical Progress: A Cross-Industry Analysis*. New York: Pergamon.

Nelson, R. R. (Ed.). (1993). *National Innovation Systems: A Comparative Analysis*. New York: Oxford University Press.

Nelson, R. R., & S. G. Winter. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA: Belknap Press of Harvard University Press.

OECD (2001). *Science, Technology and Industry Scoreboard: Towards a Knowledge-based Economy*. Paris: OECD.

Pavitt, K. (1984). Sectoral Patterns of Technical Change: Towards a Theory and a Taxonomy. *Research Policy,* 13, 343-373.

Pugh, D. S., & D. J. Hickson (1969a). The Context of Organization Structures, *Administrative Science Quarterly*, 14(1), 91-114.

Pugh, D. S., D. J. Hickson, & C. R. Hinings (1969b). An empirical taxonomy of structures of work organizations, *Administrative Science Quarterly*, 14(1), 115-126.

Schumpeter, J. ([1939], 1964). *Business Cycles: A Theoretical, Historical and Statistical Analysis of Capitalist Process*. New York: McGraw-Hill.

Skolnikoff, E. B. (1993). *The Elusive Transformation: science, technology and the evolution of international politics*. Princeton, NJ: Princeton University Press.

Sternberg, R. & C. Tamasy (1999). Munich as Germany's No. 1 high technology region: empirical evidence, theoretical explanations and the role of small firm – large firm relationships. *Regional Studies*, 33, 367-377.

Storper, M. (1997). *The Regional World - Territorial Development in a Global Economy*. New York: Guilford Press.

Theil, H. (1972). *Statistical Decomposition Analysis*. Amsterdam/ London: North-Holland.

Van der Meulen, B. (1998). Science Policies as Principal-Agent Games; Institutionalization and Path Dependency in the Relation between Government and Science. *Research Policy,* 27, 397-414.

Appendix 1: Decomposition in terms of medium- and high-tech manufacturing versus high-tech and knowledge-intensive services

Table A1: T in mbits and change of T-values at the NUTS-1 level

	All sectors	Manufacturing						Services			
		High-tech	Change (%)	Medium-tech	Change (%)	High- and medium-tech	Change (%)	Knowledge intensive	Change (%)	High-tech	Change (%)
Germany	-180.08	-163.337	-9.3	-202.135	12.2	-199.013	10.5	-161.912	-10.1	-164.037	-18.8
Baden-Württemberg	-47.71	-52.672	10.4	-62.893	31.8	-63.281	32.6	-41.168	-13.7	-46.155	-3.3
Bavaria	-90.41	-110.363	22.1	-142.965	58.1	-137.331	51.9	-67.983	-24.8	-79.023	-12.9
Brandenburg	-25.33	-20.696	-18.3	-30.564	20.7	-29.213	15.3	-21.06	-16.8	-22.447	-11.4
Hesse	-46.24	-44.662	-3.4	-58.114	25.7	-56.669	22.6	-36.101	-21.9	-35.146	-24.0
Mecklenburg-Western Pomerania	-17.68	-10.692	-39.5	-22.514	27.3	-22.71	28.4	-16.944	-4.2	-19.429	9.9
Lower Saxony	-69.3	-72.053	4.0	-94.14	35.8	-94.219	36	-54.223	-21.8	-66.376	-4.2
North Rhine-Westphalia	-49.82	-46.531	-6.6	-63.765	28.0	-61.668	23.8	-38.333	-23.1	-43.291	-13.1
Rhineland-Palatinate	-53.24	-48.53	-8.8	-75.113	41.1	-72.715	36.6	-44.538	-16.3	-50.665	-4.8
Saarland	-8.76	-9.123	4.1	-8.792	0.4	-9.721	10.9	-7.951	-9.3	-8.712	-0.5
Saxony	-43.03	-40.379	-6.2	-58.074	35.0	-56.217	30.7	-31.644	-26.5	-36.931	-14.2
Saxony-Anhalt	-32.88	-22.845	-30.5	-46.793	42.3	-43.659	32.8	-26.831	-18.4	-33.386	1.5
Schleswig-Holstein	-40.28	-41.331	2.6	-53.345	32.4	-54.838	36.1	-33.144	-17.7	-34.15	-15.2
Thuringia	-31.12	-25.059	-19.5	-45.461	46.1	-43.412	39.5	-22.593	-27.4	-29.887	-4.0

Table A2: T in mbits and change of T-values at the NUTS-2 level

	All sectors	Manufacturing						Services			
		High-tech	Change (%)	Medium-tech	Change (%)	High- and medium-tech	Change (%)	Knowledge intensive	Change (%)	High-tech	Change (%)
Germany	-180.08	-163.337	-9.3	-202.135	12.2	-199.013	10.5	-161.912	-10.1	-164.037	-8.9
Arnsberg	-17.93	-18.711	4.4	-23.859	33.1	-23.822	32.9	-11.947	-33.4	-14.806	-17.4
Brandenburg – Northeast	-5.52	-4.042	-26.8	-5.878	6.5	-5.607	1.6	-4.801	-13	-5.25	-4.9
Brandenburg – Southwest	-17.62	-15.759	-10.6	-19.135	8.6	-19.18	8.9	-15.036	-14.7	-16.32	-7.4
Brunswick	-13.81	-19.051	38.0	-18.087	31.0	-19.649	42.3	-10.506	-23.9	-15.534	12.5
Chemnitz	-21.92	-15.495	-29.3	-26.262	19.8	-25.845	17.9	-17.426	-20.5	-19.132	-12.7
Darmstadt	-17.06	-16.374	-4.0	-21.064	23.5	-20.881	22.4	-13.578	-20.4	-12.381	-27.4
Dessau	-5.34	-1.427	-73.3	-8.109	51.9	-7.713	44.4	-4.551	-14.8	-6.017	12.7
Detmold	-15.78	-11.895	-24.6	-17.794	12.8	-17.389	10.2	-13.608	-13.7	-15.21	-3.6
Dresden	-16.61	-15.325	-7.7	-19.385	16.7	-20.062	20.8	-12.858	-22.6	-15.162	-8.7
Duesseldorf	-12.63	-12.134	-3.9	-15.055	19.2	-14.968	18.5	-10.713	-15.2	-13.547	7.3
Freiburg	-8.58	-8.754	2.0	-8.983	4.7	-9.856	14.9	-7.621	-11.1	-9.094	6.0
Giessen	-3.67	-2.806	-23.5	-4.582	24.9	-4.342	18.3	-3.032	-17.4	-3.204	-12.7
Halle	-10.31	-4.612	-55.3	-12.306	19.4	-11.307	9.6	-8.788	-14.8	-4.795	-53.5
Hanover	-15.58	-10.946	-29.7	-18.66	19.8	-18.49	18.7	-12.162	-21.9	-9.756	-37.4
Karlsruhe	-25.51	-26.348	3.3	-28.749	12.7	-30.567	19.8	-22.15	-13.2	-24.036	-5.8
Kassel	-13.71	-5.462	-60.2	-13.975	1.9	-13.681	-0.2	-10.933	-20.2	-11.801	-13.9
Koblenz	-11.08	-9.439	-14.8	-11.302	2.0	-11.744	6	-9.761	-11.9	-11.991	8.2
Cologne	-16.52	-11.029	-33.2	-19.042	15.3	-18.708	13.3	-14.123	-14.5	-14.717	-10.9
Leipzig	-9.2	-6.301	-31.5	-10.196	10.8	-9.932	8	-6.958	-24.4	-8.593	-6.6
Lüneburg	-29.69	-19.320	-34.9	-38.109	28.4	-36.888	24.2	-26.414	-11	-28.161	-5.1
Magdeburg	-17.28	-14.664	-15.1	-17.65	2.1	-17.705	2.5	-15.558	-10	-20.052	16.0
Mecklenburg -Western Pomerania	-17.68	-10.692	-39.5	-22.514	27.3	-22.71	28.4	-16.944	-4.2	-19.429	9.9
Middle Franconia	-23.4	-23.846	1.9	-26.82	14.6	-27.4	17.1	-18.897	-19.2	-16.221	-30.7
Muenster	-13.84	-13.632	-1.5	-17.577	27.0	-17.551	26.8	-12.35	-10.8	-11.838	-14.5
Lower Bavaria	-11.2	-9.780	-12.7	-15.275	36.4	-15.228	36	-7.598	-32.2	-7.634	-31.8
Upper Bavaria	-41.88	-40.463	-3.4	-54.101	29.2	-53.566	27.9	-34.495	-17.6	-34.719	-17.1
Upper Frankonia	-14.16	-16.318	15.2	-20.542	45.1	-20.387	44	-10.643	-24.8	-11.732	-17.1
Upper Palatinate	-17.92	-15.371	-14.2	-20.145	12.4	-20.367	13.6	-14.145	-21.1	-15.118	-15.6
Rheinhessen-Palatinate	-33.07	-34.937	5.6	-49.102	48.5	-48.831	47.6	-28.737	-13.1	-34.158	3.3
Saarland	-8.76	-9.123	4.1	-8.792	0.4	-9.721	10.9	-7.951	-9.3	-8.712	-0.5
Schleswig-Holstein	-40.28	-41.331	2.6	-53.345	32.4	-54.838	36.1	-33.144	-17.7	-34.15	-15.2
Swabia	-19.04	-22.383	17.6	-26.878	41.2	-27.671	45.3	-13.094	-31.2	-16.286	-14.5
Stuttgart	-23.61	-24.511	3.8	-28.782	21.9	-29.855	26.4	-20.072	-15	-23.589	-0.1
Thuringia	-31.12	-25.059	-19.5	-45.461	46.1	-43.412	39.5	-22.593	-27.4	-29.887	-4.0
Trier	-4.78	-1.416	-70.4	-5.737	20.0	-5.256	9.9	-4.568	-4.5	-3.392	-29.0
Tuebingen	-10.47	-12.039	15.0	-12.639	20.7	-13.375	27.7	-9.12	-12.9	-6.735	-35.7
Lower Franconia	-22.94	-14.503	-36.8	-26.163	14.0	-26.572	15.8	-18.563	-19.1	-19.201	-16.3
Weser-Ems	-26.72	-21.168	-20.8	-34.547	29.3	-33.875	26.8	-21.611	-19.1	-28.17	5.4

List of Working Papers of the Faculty of Economics and Business Administration,
Technische Universität Bergakademie Freiberg.

2000

00/1 Michael Nippa, Kerstin Petzold, Ökonomische Erklärungs- und Gestaltungsbeiträge des Realoptionen-Ansatzes, Januar.

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00/4 Jan Körnert, Unternehmensgeschichtliche Aspekte der Krisen des Bankhauses Barings 1890 und 1995, in: *Zeitschrift für Unternehmensgeschichte*, München, 45 (2000), 205 – 224.

00/5 Egon P. Franck, Jens Christian Müller, Die Fußball-Aktie: Zwischen strukturellen Problemen und First-Mover-Vorteilen, *Die Bank*, Heft 3/2000, 152 – 157.

00/6 Obeng Mireku, Culture and the South African Constitution: An Overview, Februar.

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00/11 Michael Fritsch, Christian Schwirten, R&D cooperation between public research institutions - magnitude, motives and spatial dimension, in: Ludwig Schätzl und Javier Revilla Diez (eds.), *Technological Change and Regional Development in Europe*, Heidelberg/New York 2002: Physica, 199 – 210.

00/12 Diana Grosse, Eine Diskussion der Mitbestimmungsgesetze unter den Aspekten der Effizienz und der Gerechtigkeit, März.

00/13 Michael Fritsch, Interregional differences in R&D activities – an empirical investigation, in: *European Planning Studies*, 8 (2000), 409 – 427.

00/14 Egon Franck, Christian Opitz, Anreizsysteme für Professoren in den USA und in Deutschland – Konsequenzen für Reputationsbewirtschaftung, Talentallokation und die Aussagekraft akademischer Signale, in: *Zeitschrift Führung + Organisation (zfo)*, 69 (2000), 234 – 240.

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00/18 Jan Körnert, Die Maximalbelastungstheorie Stützels als Beitrag zur einzelwirtschaftlichen Analyse von Dominoeffekten im Bankensystem, in: Eberhart Ketzel, Stefan Prigge u. Hartmut Schmidt (Hrsg.), *Wolfgang Stützel – Moderne Konzepte für Finanzmärkte, Beschäftigung und Wirtschaftsverfassung*, Verlag J. C. B. Mohr (Paul Siebeck), Tübingen 2001, 81 – 103.

00/19 Cornelia Wolf, Probleme unterschiedlicher Organisationskulturen in organisationalen Subsystemen als mögliche Ursache des Konflikts zwischen Ingenieuren und Marketingexperten, Juli.

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00/21 Egon Franck, Jens Christian Müller, Zur Fernsehvermarktung von Sportligen: Ökonomische Überlegungen am Beispiel der Fußball-Bundesliga, erscheint in: Arnold Hermanns und Florian Riedmüller (Hrsg.), *Management-Handbuch Sportmarketing*, München 2001.

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00/25 Michael Fritsch, Grit Franke, Innovation, Regional Knowledge Spillovers and R&D Cooperation, *Research Policy*, 33 (2004), 245-255.

00/26 Dieter Slaby, Kalkulation von Verrechnungspreisen und Betriebsmittelmieten für mobile Technik als Grundlage innerbetrieblicher Leistungs- und Kostenrechnung im Bergbau und in der Bauindustrie, Oktober.

00/27 Egon Franck, Warum gibt es Stars? – Drei Erklärungsansätze und ihre Anwendung auf verschiedene Segmente des Unterhaltungsmarktes, *Wirtschaftsdienst – Zeitschrift für Wirtschaftspolitik*, 81 (2001), 59 – 64.

00/28 Dieter Jacob, Christop Winter, Aktuelle baubetriebliche Themen – Winter 1999/2000, Oktober.

00/29 Michael Nippa, Stefan Dirlich, Global Markets for Resources and Energy – The 1999 Perspective - , Oktober.

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00/33 Jan Körnert, Cornelia Wolf, Branding on the Internet, Umbrella-Brand and Multiple-Brand Strategies of Internet Banks in Britain and Germany, erschienen in Deutsch: *Die Bank*, o. Jg. (2000), 744 – 747.

00/34 Andreas Knabe, Karl Lohmann, Ursula Walther, Kryptographie – ein Beispiel für die Anwendung mathematischer Grundlagenforschung in den Wirtschaftswissenschaften, November.

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2001

01/1 Michael Nippa, Strategic Decision Making: Nothing Else Than Mere Decision Making? Januar.

01/2 Michael Fritsch, Measuring the Quality of Regional Innovation Systems – A Knowledge Production Function Approach, *International Regional Science Review*, 25 (2002), 86-101.

01/3 Bruno Schönfelder, Two Lectures on the Legacy of Hayek and the Economics of Transition, Januar.

01/4 Michael Fritsch, R&D-Cooperation and the Efficiency of Regional Innovation Activities, *Cambridge Journal of Economics*, 28 (2004), 829-846.

01/5 Jana Eberlein, Ursula Walther, Änderungen der Ausschüttungspolitik von Aktiengesellschaften im Lichte der Unternehmenssteuerreform, *Betriebswirtschaftliche Forschung und Praxis*, 53 (2001), 464 - 475.

01/6 Egon Franck, Christian Opitz, Karriereverläufe von Topmanagern in den USA, Frankreich und Deutschland – Elitenbildung und die Filterleistung von Hochschulsystemen, *Schmalenbachs Zeitschrift für betriebswirtschaftliche Forschung (zfbf)*, (2002).

01/7 Margit Enke, Anja Geigenmüller, Entwicklungstendenzen deutscher Unternehmensberatungen, März.

01/8 Jan Körnert, The Barings Crises of 1890 and 1995: Causes, Courses, Consequences and the Danger of Domino Effects, *Journal of International Financial Markets, Institutions & Money*, 13 (2003), 187 – 209.

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01/13 Jan Körnert, Oliver Gaschler, Die Bankenkrisen in Nordeuropa zu Beginn der 1990er Jahre - Eine Sequenz aus Deregulierung, Krise und Staatseingriff in Norwegen, Schweden und Finnland, *Kredit und Kapital*, 35 (2002), 280 – 314.

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2002

02/1 Jan Körnert, Cornelia Wolf, Das Ombudsmannverfahren des Bundesverbandes deutscher Banken im Lichte von Kundenzufriedenheit und Kundenbindung, in: *Bank und Markt*, 31 (2002), Heft 6, 19 – 22.

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02/5 Michael Fritsch, How and Why does the Efficiency of Regional Innovation Systems Differ? in: Johannes Bröcker, Dirk Dohse and Rüdiger Soltwedel (eds.), *Innovation Clusters and Interregional Competition*, Berlin 2003: Springer, 79-96.

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2003

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03/4 Michael Fritsch, Zum Zusammenhang zwischen Gründungen und Wirtschaftsentwicklung, in Michael Fritsch und Reinhold Grotz (Hrsg.), *Empirische Analysen des Gründungsgeschehens in Deutschland*, Heidelberg 2004: Physica 199-211.

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2004

04/1 Michael Fritsch, Pamela Mueller, The Effects of New Firm Formation on Regional Development over Time, *Regional Studies*, 38 (2004), 961-975.

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04/6 Michael Fritsch, Pamela Mueller, Regional Growth Regimes Revisited – The Case of West Germany, in: Michael Dowling, Jürgen Schmude and Dodo von Knyphausen-Aufsess (eds.): *Advances in Interdisciplinary European Entrepreneurship Research Vol. II*, Münster 2005: LIT, 251-273.

04/7 Dieter Jacob, Constanze Stuhr, Aktuelle baubetriebliche Themen – 2002/2003, Mai.

04/8 Michael Fritsch, Technologietransfer durch Unternehmensgründungen – Was man tun und realistischerweise erwarten kann, in: Michael Fritsch and Knut Koschatzky (eds.): *Den Wandel gestalten – Perspektiven des Technologietransfers im deutschen Innovationssystem*, Stuttgart 2005: Fraunhofer IRB Verlag, 21-33.

04/9 Michael Fritsch, Entrepreneurship, Entry and Performance of New Businesses – Compared in two Growth Regimes: East and West Germany, in: *Journal of Evolutionary Economics*, 14 (2004), 525-542.

04/10 Michael Fritsch, Pamela Mueller, Antje Weyh, Direct and Indirect Effects of New Business Formation on Regional Employment, Juli.

04/11 Jan Körnert, Fabiana Rossaro, Der Eigenkapitalbeitrag in der Marktzinsmethode, in: *Bank-Archiv* (ÖBA), Springer-Verlag, Berlin u. a., ISSN 1015-1516. Jg. 53 (2005), Heft 4, 269-275.

04/12 Michael Fritsch, Andreas Stephan, The Distribution and Heterogeneity of Technical Efficiency within Industries – An Empirical Assessment, August.

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2005

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